REMARKS

Claims 1 and 2-8 are pending. Claims 1, 3 and 4 are amended. Claim 2 is cancelled and new claim 8 is added.

As a preliminary matter, an Information Disclosure Statement is filed herewith listing prior art cited on page 1 of the specification. The Examiner is requested to acknowledge consideration of the prior art in the next communication from the office.

Furthermore, a General Power of Attorney and a Statement under 37 C.F.R. §3.73(b) are filed herewith. The Office is requested to update the correspondence and Power of Attorney information with respect to this application.

Claims 2 and 4 were objected to due to informalities. Claims 3 and 4 have been amended as suggested by the Examiner.

Claim 1 was rejected under 35 U.S.C. §102(b) as being anticipated by **Enomoto *et al.*** (JP '872). This rejection has been overcome by amendment of claim 1 to specify that the plurality of channels disposed between the rings varies in width in a radial direction wherein the width of each channel between peaks is 0.1 to 1.0mm and narrower than the width of each valley below the peaks. **Enomoto *et al.*** does not disclose such a structure and therefore fails to anticipate the amended claims.

Claims 2 and 3 were rejected under 35 U.S.C. §103(a) as being unpatentable over **Enomoto *et al.*** in view of **Poxon *et al.*** Favorable reconsideration of this rejection is earnestly solicited.

The features of claim 2 have been incorporated into claim 1. In addition, claim 1 has been amended to clarify that the plurality of channels disposed between the rings varies in width in a radial direction wherein the width of each channel between peaks is 0.1 to 1.0mm and narrower than the width of each valley below the peaks. Furthermore, claim 1 has been amended to clarify that the rubber of the first rubber layer has a Mooney viscosity (MV) of between 15 and 45 at 100°C.

The specification as filed describes in paragraph [0004] "More particularly, since the pitch of the metal bellows tube hose tends to be reduced it is important for the rubber layer surrounding the metal bellows tube hose to fill up valleys which form between the corrugations in the metal bellows tube with rubber." In other words, it is preferred that the pitch of the metal bellows tube is narrow for improving durability of the hose, while it becomes more difficult for the rubber layer to fill up valleys (channels) and occurs poor interlaminar adhesion between the contact faces of the metal bellows tube and the first rubber layer, allowing the contact faces of the metal bellows tube to shift relative to the rubber layer.

The present invention was made to solve the above-mentioned problem and its object is to improve both of hose durability and interlaminar adhesion, simultaneously. According to the present invention, the hose durability can be improved by employing a metal bellows tube having a corrugated structure with a plurality of spaced apart rings having peaks and a plurality of channels disposed between the rings forming valleys below the peaks and the plurality of channels disposed between the rings vary in width (pitch) in a radial direction wherein the width

of each channel between peaks is 0.1 to 1.0mm and is narrower than the width of each valley below the peaks.

Further, using a rubber composition which contains at least a rubber of an acryl group and a rubber of an ethylene-propylene-diene group (EPDM) and has a Mooney viscosity (MV) of between 15 and 45 at 100°C and is flowable at low temperature to form the first rubber layer, which results in filling up the channels between the rings in the bellows structure down into the valleys (channels), even in the case where the width (pitch) of each channel between peaks is narrowed. As a result, the adhesive property between the metal bellows tube and the first rubber layer is improved and shifting between contact faces of both layers can be suppressed.

The claimed rings are not a spiral structure and the channels are not of a spiral geometry. That is, the structure of the metal bellows tube is a structure with separate and independent channels, which provide better durability and better flexibility than a spiral structure. This is in contrast to the preferred embodiment of **Enomoto** ***et al.*** which describes a spiral accordion tube. **Enomoto** ***et al.*** describes using a pitch of 2mm spiral accordion tube and does not teach or suggest a width of each channel between peaks being 0.1 to 1.0mm and narrower than the width of each valley below the peaks, as required by the amended claims.

Poxon ***et al.*** fails to provide the teachings which **Enomoto** ***et al.*** lacks. Although **Poxon** ***et al.*** shows in Fig. 3 a pitch which varies in the radial direction, **Poxon** ***et al.*** does not teach or suggest that the width of each channel between peaks is 0.1 to 1.0mm and narrower than the width of each valley below the peaks. Accordingly, even if one of ordinary skill in the art would

have combined the teachings of **Enomoto *et al.*** and **Poxon *et al.***, the combination would fail to teach each and every feature of the presently claimed invention.

The claimed shaped and configuration of the invention would not have been determined through routine experimentation as asserted by the Examiner. As discussed in the present specification, hose durability can be improved when the width (pitch) of each channel between peaks is narrowed to 01 to 1.0mm. However, such dimensions make it difficult to fill rubber in a manner which would extend throughout each valley (channel) of the metal bellows, such that the interlaminar adhesion between the contact faces of the metal bellows tube and the first rubber layer is deteriorated, allowing the contact faces of the metal bellows tube to shift relative to the rubber layer. The claimed invention makes it possible to sufficiently fill each channel such that the interlaminar adhesion between the metal bellows tube and the first rubber layer is improved and shifting between contact faces of both layers can be suppressed by employing the claimed composition which has a Mooney viscosity (MV) of between 15 and 45 at 100°C. The combination of the cited references fails to teach or suggest these features of the invention.

It should be noted that **Poxon *et al.*** describes that a sheath 48 of soft, resilient material is located between the braided sleeve 38 and the corrugated tube 30. This teaching does not that the rubber is sufficiently filled into each valley (channel) of the metal bellows of the metal bellows tube.

Applicants have prepared additional comparative experiments to show the unexpected results associated with the claimed material having a Mooney viscosity (MV) as claimed. The additional data shows that the examples in accordance with the claimed invention not only have

excellent adhesive properties but also excellent durability. In contrast, a Mooney viscosity outside the claims shows poor processability (extrusion property) and/or poor durability. The additional experimental data is attached, and can be provided in the form of a Declaration of a 37 C.F.R. §1.132 if required by the Examiner.

It is noted that the Examiner argues that one of ordinary skill in the art would have combined the references such that "it would be more difficult for the rubber to pull away from the metal bellows, which is the desire of **Enomoto** ***et al.***" The Examiner is requested to highlight where **Enomoto** ***et al.*** provides such a teaching.

Claim 4 was rejected under 35 U.S.C §103(a) as being unpatentable over **Enomoto** ***et al.*** in view of **Poxon** ***et al.*** further in view of **Ikeda** ***et al.*** Favorable reconsideration of this rejection is earnestly solicited.

Ikeda ***et al.*** fails to provide the teachings which **Enomoto** ***et al.*** and **Poxon** ***et al.*** lack.

Ikeda ***et al.*** (US2002/0074050) only describes that bellows may be used for the metal layer and does not describe the bellows structure specifically. It is quite natural that there is no description or suggestion about employing "the metal bellows tube having a corrugated structure with a plurality of spaced apart rings having peaks and a plurality of channels disposed between the rings forming valleys below the peaks and the plurality of channels disposed between the rings vary in width in a radial direction wherein <u>the width of each channel between peaks is 0.1 to 1.0mm and narrower than the width of each valley below the peaks."</u>

Further, **Ikeda** ***et al.*** describes that a rubber layer is formed by employing a rubber composition including rubber such as EPDM and a resorcinol compound. However, there is no

description or suggestion about employing "a rubber composition including at least a rubber of an acryl group and a rubber of an ethylene-propylene-diene group and having a Mooney viscosity MV of between 15 and 45 at 100°C and being flowable at low temperature." Thus, **Ikeda** ***et al.*** does not describe the effects of the present invention that it is possible to fill up the channels between the rings in the bellows structure down into the valleys with the rubber, even in the case where the width (pitch) of each channel between peaks is narrowed to 0.1 to 1.0mm, so that the interlaminar adhesion between the metal bellows tube and the first rubber layer is improved and shifting between contact faces of both layers can be suppressed by employing a composition including at least a rubber of an acryl group and a rubber of an ethylene-propylene-diene group and having a Mooney viscosity (MV) of between 15 and 45 at 100°C and being flowable at low temperature. Therefore, even if **Ikeda** ***et al.*****,** **Enomoto** ***et al.*** and **Poxon** ***et al.*** are combined, the present invention cannot be attained. Thus, the present invention has the inventive step.

Claims 5 and 7 were rejected under 35 U.S.C. §103(a) as being unpatentable over **Enomoto** ***et al.*** in view of **Poxon** ***et al.*** and **Ikeda** ***et al.*** and further in view of **Kubota** ***et al.*** Favorable reconsideration of this rejection is earnestly solicited.

Kubota ***et al.*** also fails to provide the teachings which the primary references lack.

Kubota ***et al.*** (US 6,689,843) describes that an acrylic rubber composition including a carboxylated acrylic rubber is employed in an automotive field. However, **Kubota** ***et al.*** does not describe a flexible hose comprising a metal bellows tube having a first rubber layer on the outer circumference thereof and an exterior layer formed on the outer circumference of the first

rubber layer. It is quite natural that there is no description or suggestion about employing "the metal bellows tube having a corrugated structure with a plurality of spaced apart rings having peaks and a plurality of channels disposed between the rings forming valleys below the peaks and the plurality of channels disposed between the rings vary in width in a radial direction wherein the width of each channel between peaks is 0.1 to 1.0mm and narrower than the width of each valley below the peaks."

Further, **Kubota *et al.*** does not describe or suggest employment of "a rubber composition including at least a rubber of an acryl group and a rubber of an ethylene-propylene-diene group and, having a Mooney viscosity (MV) of between 15 and 45 at 100°C and being flowable at low temperature."

Thus, **Kubota et *al.*** does not describe the effects of the present invention in which it is possible to fill up the channels between the rings in the bellows structure down into the valleys with the rubber, even in the case where the width (pitch) of each channel between peaks is narrowed to 0.1 to 1.0mm, so that the interlaminar adhesion between the metal bellows tube and the first rubber layer is improved and shifting between contact faces of both layers can be suppressed by employing a composition including at least a rubber of an acryl group and a rubber of an ethylene-propylene-diene group and having a Mooney viscosity (MV) of between 15 and 45 at 100°C and being flowable at low temperature.

Therefore, even if Kubota *et al.*, Ikeda et al, **Enomoto *et al.*** and **Poxon *et al.*** are combined, the present invention cannot be attained.

Claim 6 was rejected under 35 U.S.C. §103(a) as being unpatentable over **Enomoto** ***et al.*** in view of **Poxon** ***et al.*** and **Ikeda** ***et al.*** further in view of **Ozawa** ***et al.*** and **Watanabe** ***et al.*** Favorable reconsideration of this rejection is earnestly solicited.

Ozawa ***et al.*** and **Watanabe** ***et al.*** fail to provide the teachings which the primary references lack.

Ozawa ***et al.*** (US 6,492,454) describes ethylene acrylic rubber containing an epoxy group, such as ethylene-acrylic acid ester-glycidyl methacrylate copolymer rubber.

Watanabe ***et al.*** (US 6,166,143) describes the blend ratio of ethylene and acrylic ester.

However, both of **Ozawa** ***et al.*** and **Watanabe** ***et al.*** do not describe a flexible hose comprising a metal bellows tube having a first rubber layer on the outer circumference thereof and an exterior layer formed on the outer circumference of the first rubber layer. It is quite natural that there is no description or suggestion about employing "the metal bellows tube having a corrugated structure with a plurality of spaced apart rings having peaks and a plurality of channels disposed between the rings forming valleys below the peaks and the plurality of channels disposed between the rings vary in width in a radial direction wherein <u>the width of each channel between peaks is 0.1 to 1.0mm and narrower than the width of each valley below the peaks."</u>

Further, both of **Ozawa** ***et al.*** and **Watanabe** ***et al.*** do not describe or suggest employment of "a rubber composition including at least a rubber of an acryl group and a rubber of an ethylene-propylene-diene group and <u>having a Mooney viscosity (MV) of between 15 and 45 at 100°C</u> and being flowable at low temperature."

Thus, both of **Ozawa** ***et al.*** and **Watanabe** ***et al.*** fail to describe the effects of the present invention that it is possible to fill up the channels between the rings in the bellows structure down into the valleys with the rubber, even in the case where the width (pitch) of each channel between peaks is narrowed to 0.1 to 1.0mm, so that <u>the interlaminar adhesion between the metal bellows tube and the first rubber layer is improved and shifting between contact faces of both layers can be suppressed</u> by employing a composition including at least a rubber of an acryl group and a rubber of an ethylene-propylene-diene group and <u>having a Mooney viscosity (MV) of between 15 and 45 at 100°C</u> and being flowable at low temperature.

Therefore, even if **Ozawa** ***et al.***, **Watanabe** ***et al.***, **Ikeda** ***et al.***, **Enomoto** ***et al.*** and **Poxon** ***et al.*** are combined, the present invention cannot be attained.

New claim 8 has been added which is directed to a method of producing a flexible hose. The cited references do not teach or suggest the features of set forth in the new claim.

For at least the foregoing reasons, the claimed invention distinguishes over the cited art and defines patentable subject matter. Favorable reconsideration is earnestly solicited.

Should the Examiner deem that any further acts by applicants would be desirable to place the application in condition for allowance, the Examiner is encouraged to telephone applicant's undersigned attorney.

If this paper is not timely filed, Applicants respectfully petition for an appropriate extension of time. The fees for such an extension or any other fees that may be due with respect to this paper may be charged to Deposit Account No. 50-2866.

Respectfully submitted,
WESTERMAN, HATTORI, DANIELS & ADRIAN, LLP

Stephen G. Adrian
Attorney for Applicants
Registration No. 32,878
Telephone: (202) 822-1100
Facsimile: (202) 822-1111

SGA/mra
Enclosures: Experimental Data
IDS
Power of Attorney
Form 3.73(b)

Experimental Data

First, in accordance with the description in paragraphs [0056] to [0065], the following flexible hoses were manufactured, respectively. A flexible hose (Example A) was manufactured by employing the material having a Mooney viscosity (MV) of 15 (the lower limit) at 100°C for forming the first rubber layer. A flexible hose (Example B) was manufactured by employing the material having a Mooney viscosity (MV) of 45 (the upper limit) at 100°C for forming the first rubber layer. A flexible hose (Comparative Example A) was manufactured by employing the material having a Mooney viscosity (MV) of 10 (below the lower limit) at 100°C for forming the first rubber layer. A flexible hose (Comparative Example B) was manufactured by employing the material having a Mooney viscosity (MV) of 50 (over the upper limit) at 100°C for forming the first rubber layer.

[EXAMPLE A]

(Preparation of Materials for First Rubber Layer)

One hundred parts of EPDM (Esprene 5754, manufactured by Sumitomo Chemical Co., Ltd.; Viscosity (MV): 30/100°C); 1 part of the modified Resorcin-formaldehyde resin (Sumikanol 620, manufactured by Sumitomo Chemical Co., Ltd.) as a compound of a resorcinol group; 5 parts of an epoxy resin of bisphenol A type (Epikote 828, manufactured by Yuka-Shell Epoxy K. K.) as an epoxy resin; 100 parts of carbon black (Seast SO, manufactured by Tokai Carbon K. K.); and 100 parts of a process oil (Diana Process Oil PW-380, manufactured by Idemitsu Kosan Co. Ltd.) were mixed by a Banbary mixer. To this mixture, 6 parts of di-t-butylperoxy-

diisopropylbenzene (Peroximon F-40, manufactured by NOF Corporation) as a vulcanizing agent of a peroxide group; 1 part of a reactive monomer (Hi-Cross ED-P, manufactured by Seiko Chemical Co., Ltd.); and 1 part of a methylated formaldehyde-melamine polymer (Sumikanol 507A, manufactured by Sumitomo Chemical Co., Ltd.) as a melamine resin were added. The resulting mixture was mixed by a roll to give materials used for a first rubber layer, which had the viscosity (MV) of 15 at 100°C.

(Preparation of Materials for External Layer)

The materials for forming an external layer were prepared in accordance with the description of paragraphs [0058] and [0059] of the present invention.

(Manufacturing of Flexible Hose)

A flexible hose was manufactured in accordance with paragraphs [0060] and [0061] of the present invention. First, a metal bellows tube having the bellows structure wherein the width of each channel between peaks was narrow (1.0 mm) and the width of each channel below the peaks was wide was formed, and a mandrel was inserted into the inside of the metal bellows tube. Secondly, the first rubber layer, prepared as described above, was heated at about 100°C to increase flowability and an extrusion molding was carried out on the surface of the metal bellows tube, using the rubber composition. Then, a reinforcing thread (aramid thread) was wound on the outer circumferential face of the molded first rubber layer to form a reinforcing layer. Next, an extrusion molding was carried out on the outer circumferential face of the reinforcing layer, using the above materials for an external layer. After full vulcanization of the rubber by heating at about

160°C for 45 minutes, the mandrel was pulled out of the metal bellows tube to produce a flexible hose (with e.g. an inside diameter: 6 mm) which includes the first rubber layer formed in the outer circumferential face of the metal bellows tube, the reinforcing layer formed on the outer circumferential face of the first rubber layer and the external layer formed on the outer circumferential face of the reinforcing layer.

[EXAMPLE B]

(Preparation of Materials for First Rubber Layer)

The materials for forming a first rubber layer was prepared in the same manner as in EXAMPLE A except that 100 parts of EPDM (Esprene 522, manufactured by Sumitomo Chemical Co., Ltd.) was used instead of 100 parts of EPDM (Esprene 5754, manufactured by Sumitomo Chemical Co., Ltd.; Viscosity (MV): 30/100°C) and the mixing amount of process oil (Diana Process Oil PW-380, manufactured by Idemitsu Kosan Co. Ltd.) was changed to 70 parts. The thus prepared materials for forming the first rubber layer had the viscosity (MV) of 45 at 100°C.

(Manufacturing of Flexible Hose)

A flexible hose was manufactured in the same manner as in Example A except that the above materials were used for forming the first rubber layer.

[COMPARATIVE EXAMPLE A]

(Preparation of Materials for First Rubber Layer)

The materials for forming a first rubber layer ~~was~~ were prepared in the same manner as in EXAMPLE A except that the mixing amount of carbon black (Seast SO, manufactured by Tokai Carbon Co., Ltd.) was changed to 50 parts and the mixing amount of process oil (Diana Process Oil PW-380, manufactured by Idemitsu Kosan Co. Ltd.) was changed to 150 parts. The thus prepared materials for forming the first rubber layer had the viscosity (MV) of 10 at 100°C.

(Manufacturing of Flexible Hose)

A flexible hose was manufactured in the same manner as in Example A except that the above materials were used for forming the first rubber layer.

[COMPARATIVE EXAMPLE B]

(Preparation of Materials for First Rubber Layer)

The materials for forming a first rubber layer ~~was~~ were prepared in the same manner as in EXAMPLE A except that 100 parts of EPDM (Esprene 522, manufactured by Sumitomo Chemical Co., Ltd.) was used instead of 100 parts of EPDM (Esprene 5754, manufactured by Sumitomo Chemical Co., Ltd.; Viscosity (MV); 30/100°C) and the mixing amount of process oil (Diana Process Oil PW-380, manufactured by Idemitsu Kosan Co. Ltd.) was changed to 60 parts. The thus prepared materials for forming the first rubber layer had the viscosity (MV) of 50 at 100°C.

(Manufacturing of Flexible Hose)

A flexible hose was manufactured in the same manner as in Example A except that the above materials were used for forming the first rubber layer.

Next, the property of each hose of the EXAMPLES and the COMPARATIVE EXAMPLES was evaluated according to the description of paragraphs [0069] to [0072]. Further, processability (extrusion property and filling property) was also evaluated in accordance with the following criteria. These results are shown in Table 1 below.

[Processability (extrusion property)]

Processability (extrusion property) of the first rubber layer material was evaluated when extrusion molding each first rubber layer material onto an outer peripheral surface of the metal bellows tube. The case where the material could be molded onto the metal bellows tube was evaluated as good (O), while the case where the material could not be molded or the case where the shape could not be retained and the material drooped was evaluated as poor (X).

[Processability (filling property)]

Each first rubber layer material was extruded onto an outer peripheral surface of the metal bellows tube and then vulcanized. Then, the metal bellows tube was halved and how far the material was filled into the valley of the metal bellows tube was confirmed. The case where the material was filled into the valley at 100% was evaluated as good (O), while the case where air existed between the material and the valley of the metal bellows tube was evaluated as poor (X).

Table 1

	Example		Comparative Example	
	A	B	A	B
Processability				
Extrusion property	O	O	x	O
Filling property	O	O	O	x
Adhesion strength (kg/25mm)	2.5	2.8	2.5	2.9
Separation	O	O	O	O
Durability	O	O	O	x
Viscosity of compound for first rubber layer (MV/100°C)	15	45	10	50

The above result shows that the Example A and the Example B had not only excellent adhesive properties between the first rubber layer and the reinforcing layer but also excellent durability without shift between contact faces of the metal bellows tube and the first rubber layer.

On the other hand, the above result shows that the Comparative Example A had poor processability (extrusion property) because of extremely low viscosity of the first rubber layer material. Further, it shows that Example B had poor processability (filling property) because of extremely high viscosity of the first rubber layer material and difficulty in filling of the first layer material, and also had poor durability.